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EFFECT OF VIBRATION STIMULATION ON THE ULTRASTRUCTURE OF MECHANORECEPTOR - PACHINIAN CORPUSCLES

by

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В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

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EFFECT OF VIBRATION STIMULATION ON THE ULTRASTRUCTURE OF MECHANORECEPTOR - PACHINIAN CORPUSCLES.

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Ultrastructural changes in the nervous ending of mechanoreceptors of the Pachinian uscles following adequate vibration treatment have been investigated. A formation esicles similar to synaptic ones bordering mitochondria was seen. The significance of e vesicles in the process of adaptation is suggested.
Changes in the ultrastructure of mitochondria were traced at early stages of irrita-, these changes may be involved in the synthesis of macroergic substances.

Up to now investigations of ultrastructure of mechanoreceptors - Pachinian corpuscles - were conducted on unexcited receptors (Pease and Quilliam, 1957; Mirkin, etc., 1967), while changes, which occur during adequate stimulation, remained without attention. Earlier it was established that the most adequate form of stimulation of the Pachinian corpuscles is vibration (Mirkin, etc., 1967). It was shown on the basis of the observations of cyclic variations in the threshold excitation that the Pachinian corpuscles possess resonance properties (Mirkin, 1966).

Material and procedure.

Experiments were conducted at 25°C on Pachinian corpuscles,

obtained from mesentery of cat. One group of receptors (control) was maintained for 15 min. in a Krebs-Henseleit solution, after which it was fixed, another - after 10-minute rest underwent vibration stimulation with a frequency of 120 Hz and the force of 150 dynes. The time of stimulation for different receptors was 5, 10, 20 or 40 s. After action the material was immediately fixed with 2.5% solution of glutaraldehyde on a phosphate buffer (pH 7.2) at 0° for 1 hour with the subsequent additional fixation by 2% solution of tetroxide tetroxide of osmium on the phosphate buffer for 40 min. After dehydration in alcohols the Pachinian corpuscles poured into the alardite.

Results.

Fig. 1 (see inclusively VII) shows transverse section of nerve end of control receptor. Nerve end has a section of elliptic form, its longitudinal axis is oriented in the direction of "fissure" in the internal bulb. The plasmatic membrane of nerve end forms the folds, which convert into the large apophyses near the "fissure". Cytoplasm contains the numerous proto-neurofibrils, which have the form of dark granules with size of 50 Å or short cylinders in the transverse section. This testifies about the orientation of proto-neurofibrils longitudinal with respect to the nerve end. Mitochondria are located predominantly along the periphery of nerve end near the plasmatic membrane, but their greatest accumulation is observed near the "fissure". Are there located scarce canals and cisterns of smooth

endoplasmic network and single bright vesicles with diameter 250-300 Å.

Fig. 2 (see inclusively VII) presents section of nerve end after vibration stimulation for 5 s. Is observed bloating of separate mitochondria; in such mitochondria the matrix becomes electron-transmissive.

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Fig. 3 and 4 (see inclusively VII) show section of nerve end after vibrations for 10 s. It is evident that the thickness of proto-neurofibrils increases to 80 Å. Impression is created, that the electron density of proto-neurofibrils somewhat grows. Virtually all mitochondria are surrounded by numerous vesicles with a diameter of 250-280 Å, the distances between which are commensurate with their quantity. They are located 100-300 Å from the membranes, which limit mitochondria. Separate vesicles are detected near the plasmatic membrane, but they never are observed in the cytoplasm of cell-satellites of internal bulb or external capsule. Vesicles around the mitochondria are observed and after 20-per-second vibrations (Fig. 5; see inclusively VIII), but, as a rule, were absent after 40-per-second stimulations (Fig. 6). It is necessary to note that in the rare cases the vesicles around the mitochondria were visible after 5- and 40-per-second vibration stimulations, that, possibly, points to the high lability of the described vesicular structures.

As is known, processes of onset and propagation of excitation are accompanied by formation and transportation of cholinergic mediators, included in number of cases into synaptic vesicles (Whittaker et al, 1964; Gray and Guillery, 1966). Similar vesicles were described in dendrites (Blacksted and Kjaerjeim, by 1961; Elfvin, 1963), the gustatory kidneys (Trujillo-Cenoz, 1957), the hair cells of organ of Corti (Vinnikov, 1966), to the axoplasm of the Pachinian corpuscles (Pease and Quilliam, 1957), especially in the region of the "fissure" (Mirkin, etc., 1967). However, these vesicles were detected irregularly, also, in a small quantity.

It was of interest to explain, are discovered vesicles by carriers of cholinergic mediators. In view of the great difficulties of the direct detection of mediators in the Pachinian corpuscles we attempted to detect in the nerve ends the enzymes, which esterify the mediators indicated. For this purpose histochemical investigation with the aid of a light microscope was carried out. Was discovered, just as in the works of Portugalov (1955) and Ulumbekov (1964), the appearance of a reaction product within the limits of nerve end. On the basis of this (in accordance with the representations about nature of the receptor surface as about the peculiar formation of the "extended synapse" - (Shabadash, 1968) it is possible to assume that the vesicles discovered by us are similar to the synaptic.

Previously was discussed possibility of onset of vesicles in synaptic terminations from internal membranes of mitochondria

(Dyachkova, etc., 1962). The arrangement of vesicles in immediate proximity with the mitochondria can be the indirect confirmation of a connection of these two structures. Possibly, the described vesicles appear due to budding, similar to pinocytosis.

Obtained by us data show that shaping of vesicles occurs extremely rapidly. Vesicles around the mitochondria were observed after only 5s in some experiments. About the same is testified that never could not meet the vesicles during their budding; they were detected always more narrowly with those formed. On the other hand, the onset of vesicles continues relatively not long. The vesicles usually were not encountered after 40 s. of vibration action. Probably, this phenomenon to some degree explains the mechanism of the adaptation, which appears as a result of depletion of the ability of mitochondria to form vesicles. For a while is required, in order to supplement the supply of mediators, and possibly, also materials for the formation of the membranes around the vesicles. Electrophysiological investigations showed that after 40-per-second stimulations the pulse activity becomes noticeably less frequent (Fig. 7). After certain leisure the activity is restored.

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In early stages of vibration stimulation (5 s.) is discovered bloating of mitochondria. Earlier it was shown (Mashanskiy and Rogozkin, 1965), that an increase of cellular activity is accompanied by bloating of mitochondria, during which is facilitated the

metabolism of the macroergic connections, in particular necessary for the creation of electric potential in the nerve end.

Resume.

Is studied change in ultrastructure of nerve end of Pachinian corpuscles after adequate vibration stimulation. The appearance of vesicles of the type of synaptic, that lie is discovered by border around the mitochondria. In connection with the rapid onset and disappearance of the vesicles indicated is presented the hypothesis about their value in the process of adaptation. In the early stages of excitation are discovered changes in the ultrastructure of the mitochondria, which can be connected with the process of the formation of macroergic compounds.

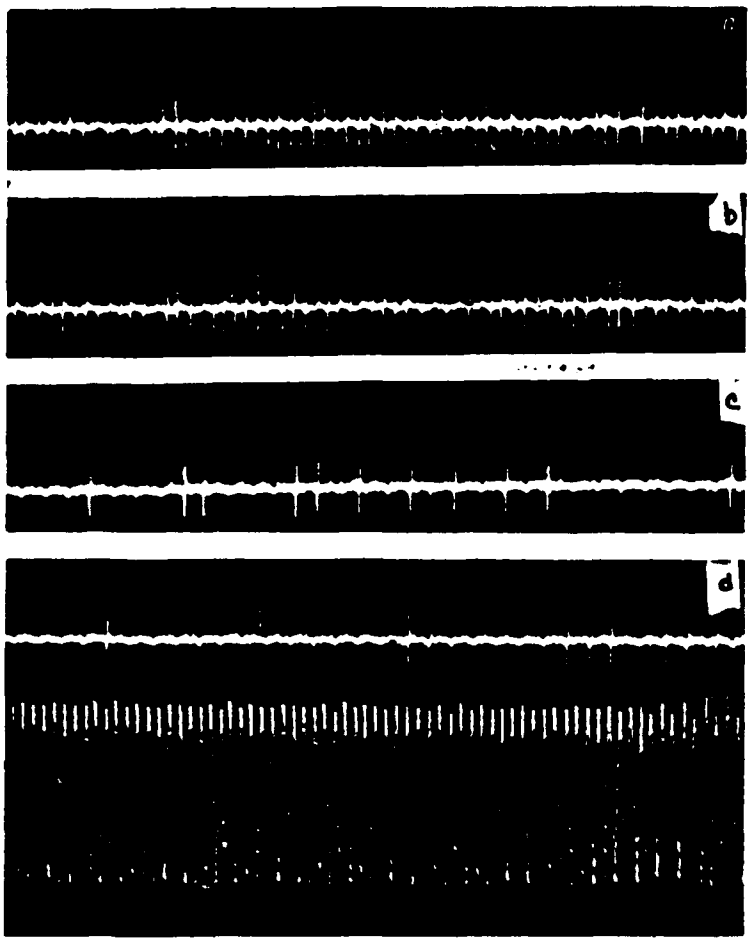

Fig. 7. Recording of response of receptor during vibration stimulation with frequency 120 hertz. a) after 10 s, stimulation, b) 20, c) 30, d) 40 s, below - time mark.

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